

PERFORMANCE OF PARTIALLY SIGHTED WITH
RANDSIGHT[®] I EQUIPPED WITH AN X-Y PLATFORM

by

Samuel M. Genensky, Ph.D.
Hubert L. Moshin, O.D.
Harold E. Petersen, Ph.D.

January 1973

RANDSIGHT[®] is a Certification Mark of The Rand Corporation.

HV5702
C286
P416

P-4943

Any views expressed in this paper are those of the authors. They should not be interpreted as reflecting the views of The Rand Corporation or the official opinion or policy of any of its governmental or private research sponsors. Papers are reproduced by The Rand Corporation as a courtesy to members of its staff.



ABSTRACT

PERFORMANCE OF PARTIALLY SIGHTED WITH
RANDSIGHT[®] I EQUIPPED WITH AN X-RAY PLATFORM^[-Y]

by

Samuel M. Genensky, Ph.D.
Hubert L. Moshin, O.D.
Harold E. Petersen, Ph.D.

A test is described which has been used to determine how well a partially sighted subject can read and write with the help of the closed circuit TV system, RANDSIGHT[®] I. The procedure is designed to build up the subject's confidence in himself by emphasizing how much he can see and how much he can accomplish with his residual vision. Over 120 subjects have been tested and the results are given for 81 of them.

The research reported in this paper was made possible by a grant from the Social and Rehabilitation Service of the U.S. Department of Health, Education and Welfare.

RANDSIGHT[®] is a Certification Mark of The Rand Corporation.

Comp. 10/78

HV5702
C286
P416
copy one

I. INTRODUCTION

Since 1966, The Rand Corporation has been involved in the design, fabrication, and informal testing of closed circuit TV (CCTV) systems that enable many persons with severely impaired vision to read, write, and perform other operations requiring precise eye-hand coordination.^{1,2,3,4,5,6}

Initially financed by Rand itself, since 1970 this work has been funded mainly by the Social and Rehabilitation Service of the U.S. Department of Health, Education, and Welfare. Some support has also been provided by donations from private citizens. Rand has also continued to support part of the project with its own funds.

An indication of the strong interest in Rand's work in this area was provided by the response to an article in the *Reader's Digest* in January 1971 on our RANDSIGHT research.⁷ As a result of this article, we received over 5000 letters, cards, and telephone calls from people seeking aid for themselves, their patients, or friends and relatives. Over 120 partially sighted people visited Rand in person. It was from these visitors that we obtained the experimental results described in this report.

We tried to see as many as possible of the partially sighted who directly or indirectly sought our assistance and who were able to come to our offices. Each partially sighted person (hereafter referred to as "subject") who visited our facility was given about two hours of our time, and with few exceptions, each of them made but one visit to our offices. We would have liked to have seen many of our subjects two or more times, but the demands for our time and attention were too great to permit us to do this. Our records show that from January 1971 through April 1972, we had seen over 120 subjects and we had communicated by mail or phone with over 5000 other people who have visual problems or have family or friends who are partially sighted.

Another important indication of the interest and value of our RANDSIGHT research is that hundreds of CCTV systems, based in large measure on the results of our research, have been produced and sold to government agencies and private individuals and are being used

successfully in schools, in libraries, on the job, and in the home. These systems are now helping students to work efficiently with ordinary study materials; assisting persons of working age to obtain or retain jobs; and permitting the elderly to read, write, and perform other tasks essential to their independence and social adjustment.

Neither The Rand Corporation nor the project staff has any financial interest in any company that manufactures, distributes, or sells closed circuit TV systems for the partially sighted. Rand makes the results of its research freely available to any person or organization interested in helping the visually impaired.

II. DESCRIPTION OF RANDSIGHT I

RANDSIGHT I consisted primarily of two Shibaden (MV-903) TV monitors, a Shibaden (HV-15 or HV-15S) TV camera, a 6-to-1 Canon 16.5-95-mm zoom lens equipped with a plus 4 portrait lens, an Art Beam-Lite 75 illuminator, an X-Y Platform, and a supporting shelf.

The TV monitors were symmetrically placed on either side of the down-pointing camera and rested on shelves that were normally kept at a height of $11\frac{1}{2}$ in. above the working surface. They could be pulled toward or pushed away from the viewer over a distance of about 8 in. (from about 4 in. to 16 in. behind the front edge of the working surface), and they could be raised or lowered slightly, although this was rarely done. Each monitor was equipped with circuitry and controls that permitted it (1) to display an image with a normal or reversed gray scale, and (2) to vary the location and height of the electronic window on the monitor screen.

The TV camera could be moved up and down for focusing over a distance of 27 in. by means of a reversible motor and lead screw, and could also be rotated about its optical axis. The latter motion permitted it to present an erect image of printed or handwritten material no matter what the orientation of that material was relative to the working surface.

The zoom lens could be used with or without its 1.5x or 2x extenders. Without an extender, the image it and the camera produced on a 9-in. monitor had a linear magnification of between about 1x and 6x. If linear magnifications in excess of 12x were needed, the zoom lens was removed, and a fixed focal length lens with a bellows extender was used in its place. The latter produced magnifications in excess of 30x.

The X-Y Platform rested on the supporting shelf below the camera and was used for reading and writing. The supporting shelf was 60 in. long and 30 in. deep, and its upper surface was 29 in. above the floor.

This instrument was basically the one that was used throughout the informal testing program. However, it did undergo some changes during the test period.

During January and part of February 1971, we operated the instrument with either room illumination only or with additional illumination provided by four 150-w dichroic spot lamps located about 3 ft above the supporting shelf and controlled by a dimmer switch. In mid-February 1971, we installed two Bausch & Lomb illuminators (Cat. No. 31-35-30) and worked with them until we installed the Art Beam-Lite 75 in June 1971. The illumination available from the Art Beam-Lite 75 is remarkably uniform, with a maximum effective intensity of 50 footcandles.

The camera mount in use throughout most of the test program did not permit rotation of the camera about its optical axis, but rather permitted limited rotation about another vertical axis. This had the effect of producing an erect image on a TV monitor for X-Y Platform orientations that favored right-handed persons, particularly with respect to writing.

At least one monitor was equipped with an electronic window in the spring of 1971, and at least one had contrast reversal capability before May 1970.

Figures 1 and 2 show RANDSIGHT I as it appeared in the early spring of 1971.



Fig. 1 - X-Y Platform being used for writing in conjunction with
RANDSIGHT I



Fig. 2 - X-Y Platform being used for writing in conjunction with
RANDSIGHT I

III. TEST PROCEDURE

Although our testing program was informal, it did develop a somewhat predictable format, which is described below.

First, the subject was asked to supply such data as his name, address, age, and sex; the nature of his visual disorders, when those disorders were known or thought to have originated, and when they were first detected; the extent of the subject's formal education and whether he was a student, employed, unemployed, or retired. This data gathering was usually followed by Genensky giving a detailed and frank description of his own visual disorder, including its history, the extent of his visual field, and the level of his visual acuity. Thus, the subject was made aware that he was dealing with someone who was himself partially sighted and hence understood firsthand what it was to be visually impaired. In most cases, it turned out that the subject's visual acuity exceeded Genensky's. If the subject or family or friends who accompanied him to our offices wanted additional information regarding Genensky--for example, his education, career, or methods of coping with and integrating into the sighted society--that information was gladly provided. Our policy of trying to answer all questions played an important part in placing the subject at his ease, particularly if he had more residual vision than Genensky. For in that case, the subject was able to make a comparison that often led him to conclude that, visually speaking, he was much less impaired than he had previously thought, and as a result might be in a better position to cope with his partial eyesight. Our open exchange of vision information also helped the subject's family and friends to grasp a more realistic understanding of his visual capability; consequently, they were in a better position to provide him with the help and assistance that he *actually* needed rather than the help and assistance they had *perceived* he needed.

The subject's distance visual acuity was measured at 5 or 10 ft, using such tests as the Feinbloom "Distance Test Chart for the Partially Sighted," the Good-Lite "Symbols for 10 Feet," or the "Sloan Letters for 20 Feet," and the results were converted to the equivalent Snellen acuity at 20 ft. Whenever possible we used the Feinbloom chart because, at 5 or 10 ft, almost all of our subjects could resolve

at least one or two numbers on that chart. Had we used the conventional approach of asking our subjects to read at 20 ft from a chart designed for persons with relatively good vision (e.g., the "Snellen" types), most of our subjects would have had to report that they could not resolve a single symbol. We firmly believe that the partially sighted, like the normally sighted, do not wish to be placed in a position in which they are guaranteed to fail. Like the fully sighted, they respond positively to an opportunity to achieve, and our entire test procedure is designed to give them every chance to succeed. We, of course, were not always successful, because some subjects do not possess the mental, mechanical, or visual capacity needed to carry out the various tasks and operations involved in our procedure. Nevertheless, we were continually on the alert to do all we could to encourage and assist our subjects.

Visual acuity was measured for both the left and right eye with and without corrective lenses. The only corrective lenses used in the procedure were those that the subject was wearing, or happened to bring with him. If he did wear or carry corrective lenses, we tried to ascertain how long he had had them, how often he wore them, and for what purposes he used them.

If the subject's visual acuity appeared to be distinctly better than Genensky's, and if we believed that it would be beneficial to him or a member of his immediate family, we asked the subject to administer the acuity test he had just completed to Genensky. The effect of this technique is often very gratifying, because the subject, his relatives, as well as others in the room are greatly encouraged by this concrete evidence that the subject can in fact see better than Genensky, and thus, in most cases, need not resign himself to coping with the sighted world as do the functionally blind, but can do so in ways that make maximum use of his residual vision.

On completing the visual acuity measurements, the subject was asked to look through a set of clear and colored transparent plastic squares in the direction of the overhead fluorescent lighting and to report for each square the color he observed. Using this test, it is remarkable how many partially sighted people have very good color

discrimination. However, this test fails to measure how well the partially sighted are able to discriminate color in the presence of ordinary room lighting or illumination that falls below that normally encountered in the office or the home. Because the discrimination threshold of the partially sighted tends to be higher, it is likely that under ordinary conditions the color discrimination of many partially sighted will prove to be distinctly inferior to that of the "normally" sighted.

The subject was then introduced to RANDSIGHT I, equipped with an X-Y Platform. This usually involved describing the instrument's various parts and how they interact. Sometimes an explanation was also given of such questions as why an electro-optical device is able to produce a brighter, higher contrast image than a pure optical device, why it is vitally important to design an instrument that the partially sighted can use naturally and comfortably, and what contrast reversal and an electronic window are and how they benefit some of the partially sighted.

The subject was shown how to read with the help of the device and was given an opportunity to read with it himself. After he had read for about 5 minutes, several measurements were made: the linear magnification of the print viewed on the monitor screen, the distance between the subject's eyes and the monitor screen, and the rate at which he read (measured in words per minute). The first two measurements permitted us to calculate the effective magnification at which he read. Usually these measurements were made two or three times during the period the subject was using RANDSIGHT I to read. In most cases, it was found that the effective magnification does not change appreciably, but the reading rate tends to increase and sometimes quite dramatically, giving the distinct impression of a learning or relearning process. Some of the increase in reading rate may be due to improvement in the subject's adroitness in handling the instrument, and some of it is probably due to the subject's actually learning or relearning to read visually. It should be noted that all measurements of the subject's reading rate were made with him reading aloud.

If the subject failed to read well with RANDSIGHT I, we did not automatically conclude that his poor performance was due entirely to his poor vision. In such cases, we inquired as to when the subject last read printed or handwritten material, how he and/or his relatives and friends would rate his reading ability, and what kinds of material he had read in the past. Such questions sometimes led us to conclude that we were not using reading material appropriate for the subject, and when we changed to more suitable material, we frequently found that the subject's interest in trying to read improved and his reading rate increased.

Usually we would have a subject read double-spaced typewritten material, newsprint, or graded readers. However, we did not discourage the subject from reading the material that he had brought with him, which generally consisted of reading matter that he considered important to his education, vocation, or leisure. Among the materials brought to our offices were law books, programming manuals, geographies, novels, magazines, and telephone directories. It should be noted that we rarely made our reading measurement using the subject's own reading matter, because we wished to avoid the possibility of obtaining abnormally high reading rates resulting from the subject's prior exposure to the context of the reading matter.

After we completed our measurements with respect to reading, we asked the subject if he would like to try to write with the help of RANDSIGHT I. Most subjects were immediately willing, although some found reading with the instrument so enjoyable that they asked if they might continue to keep reading. We, of course, tried to comply with this request, but the fact that we could devote only two hours to a subject, and rarely ever saw him a second time, often forced us to ask the subject to stop reading sooner than we would have liked to.

Some subjects showed no desire to try to write. This may be due to several causes: The subjects may never have learned to write in the sighted sense of that operation; they may perceive that their handwriting is so poor that they are not willing to show it to others; they may have forgotten how to write; or although they know how to write, they may be unwilling to do so when asked. The latter three

reasons appear to be particularly applicable to the elderly. If a subject, no matter what his age may be, has psychologically dropped out of the sighted or partially sighted community, he may refuse to try to write because he no longer possesses the motivation needed to succeed in the sighted world.

Subjects who expressed interest were given a demonstration of how to write with the help of the instrument, and they were then permitted to write themselves. We suggested that they first write or print the alphabet, whereupon they were encouraged to write words and sentences--usually of their own choosing. While the subject was writing, measurements were made of the distance between his eyes and the monitor screen, and when he stopped writing the linear magnification of the image of his handwriting was determined. Judgments of the quality of the subject's handwriting were made and, in most cases, a sample of the subject's handwriting was affixed to our record of his visit.

We found that some subjects, without the aid of optical or electro-optical instruments and without actually seeing what they were doing, were able to write fairly satisfactorily with a pen or pencil. However, when they were asked to write down a column of numbers and then to add them without the aid of RANDSIGHT I, they were unable to do so. This is due to the fact that in general the successful execution of this sequence of operations requires the use of at least some residual vision. When these subjects were asked to carry out these operations using RANDSIGHT I, they frequently succeeded, and came to realize, or perhaps were more prepared to admit, that without the aid of an optical or electro-optical device they were unable to both write and see what they were writing or had written.

Some subjects brought with them their own writing materials, for example, a ledger, a programming chart, or a checkbook. We were delighted when this occurred, and we did all we could to show them how they could use RANDSIGHT to work with these materials.

If time permitted, if the subject appeared interested, or if we believed it worthwhile, we explained to him how binoculars have helped Genensky to do such things as read a chalkboard while seated in a

classroom, read charts or slides in the course of a lecture, determine the status of a traffic signal, locate merchandise in a store, and watch movies, plays, TV, and sports events. We then showed the subject how to use our wide-angle 7 by 35 binoculars, and encouraged him to try to use them to read printed and handwritten symbols, words, and sentences that we wrote on a chalkboard. With the help of the binoculars, many subjects were able to resolve printed and handwritten material when it was 1 or 2 in. high at distances as great as 15 ft from the chalkboard. Students and adults of working age, who succeeded in using the binoculars, were particularly excited about how they might be able to use this versatile visual aid to further their education or career.

We have been surprised, and frankly shocked, to learn that few clinicians are aware of how valuable a pair of binoculars can be to a person with limited eyesight. As in the case of closed circuit TV systems for the partially sighted, we are doing all we can to inform clinicians, the partially sighted, and the general public about the potential value of this readily available and too-long-ignored visual aid.

IV. TEST RESULTS

The records of 81 subjects who have used RANDSIGHT I since it was first equipped with an X-Y Platform were selected for analysis. These were chosen on the basis of the following criteria:

1. The records contained sufficient data concerning the subject's visual disorders.
2. The subject had not been exposed to a closed circuit TV system for the partially sighted before visiting our offices.
3. The records included the subject's age, his sex, and the approximate date of onset of his visual disorders.

It must be emphasized that these subjects were not chosen at random from the overall partially sighted population. They were brought to our attention either by clinicians, educators, or rehabilitation personnel, or by themselves, their family, or friends as a result of having read or heard about our research in popular or professional articles. Most of those who came to see us were probably either highly motivated or were brought to our offices by family or friends who were anxious to help them and have them succeed.* Further, those who came to see us were either able to pay for their transportation, or their family or friends were able to bear that expense. For many of these people, transportation costs ran quite high, as they came from all parts of the nation, as well as from countries as distant as Chile and India. However, even though our subjects were not chosen at random and probably underrepresent partially sighted persons who lack motivation or have low incomes, they do represent a broad cross-section of the partially sighted with respect to such factors as age, education, visual acuity, and ocular pathology. Further, no attempt was made to filter the flow of subjects other than to discourage persons

* In a few instances, we noted that the subject was not highly motivated and that the members of his family who accompanied him appeared to have the attitude that once they had brought him to see us, their job was done, and the sooner they and he could leave the better.

who had no residual vision whatsoever in both eyes. In view of these facts, we believe that the results of our informal testing are of value and worth reporting and analyzing.

Table 1 contains a detailed breakdown of subject performance with RANDSIGHT I. Column 1 contains the code number assigned to each subject. Because we often refer to Genensky's experience with, and comments and conjectures about, our RANDSIGHT equipment, we decided to assign him the code letter "G" and to include information about him and his *current* performance with RANDSIGHT I as the first row in this table. No data concerning him or his performance appear in subsequent tables; nor are his data used in the observations made in the next section.

Column 2 gives the subject's eye disorder(s) as stated by his physician or, that not being available, by the subject, his parent, or guardian.* Column 3 gives the subject's sex, and column 4, his age. Column 5 shows whether the subject has any gross scotomas (central or peripheral).

Columns 6 and 7 give the subject's best distance visual acuity in the right (R) and left (L) eye, respectively. Here "best" means the largest numerical value of distance visual acuity measured for each eye with or without corrective lenses and recorded in equivalent Snellen acuity at 20 ft. The symbols FC and LP that appear in columns 6 and 7 stand for finger counting and light perception, respectively. The blank spots in those columns indicate that no distance visual acuity measurement was made; either we failed to make the measurement or we did try to make it but were unable to obtain a reliable value. In some cases, the subject tended to favor one eye to such an extent that it soon became clear that he was not using the other eye. When this occurred, we sometimes decided not to measure the acuity in the non-dominant eye.

Columns 8 through 12 present data regarding the results of the subject's reading with RANDSIGHT I. Column 8 gives the distance in

*Occasionally, the subject, parent, or guardian gave information regarding the visual disorder(s) in lay language; this information has been recorded here in more conventional medical terminology.

Table 1
PERFORMANCE OF PARTIALLY SIGHTED WITH RANDSIGHT I
(December 1970 to March 1972)

(1) Code No.	(2) Visual Disorder	(3) Sex	(4) Age	(5) Scotomas	(6) Best Distance Acuity with or without Rx		(8) WD	(9) LM	(10) EM	(11) Rate	(12) UF	(13) Writing			(16) UF
					R	L						WD	LM	EM	
G ^a	Corneal opacities, glaucoma	M	44	No	20/750	Nil	1½	5x	53½x	125	S	1½	2x	21x	S
1	Macular degeneration, retinitis	M	61	No	20/200		7½	6x	13x	55	S	8½	2½x	4½x	S
2	Macular degeneration, retinal hemorrhages	M	71	Yes	20/300	20/500	6½	10x	25x	50	S	7½	2½x	5½x	S
3	Optic nerve atrophy	M	88	Yes	20/400		9½	11½x	19½x	107	M	5½	5x	14½x	u
4	Macular degeneration, retinal hemorrhages	F	83	Yes	20/400	20/480	5	6½x	20½x	60	S	6½	4x	9½x	S
5	Glaucoma, macular degeneration	M	61	No	20/100	20/100	7½	3½x	7½x	50	S	6½	3½x	9x	S
6	Chorioretinitis	M	19	No	20/100	FC	5½	3½x	10x	31	S	6½	2x	4.5x	S
7	Mild albinism	F	34	No	20/200	20/200	4½	4x	14x	100	S	4½	3x	10.5x	m
8	Macular degeneration	M	79	Yes	20/550	20/550	6½	10x	25x	30	M	7	2x	4½x	m
9	Macular degeneration	M	40	Yes	20/200	20/250	12½	4x	5½x	115	S	9½	1½x	2x	S
10	Retinal detachment, macular degeneration	F	~60	Yes	20/480	20/480	8½	4x	7½x	31	S				

^aThese data for Genesky are listed for reference purposes only.

Table 1 -- continued

(1) Code No.	(2) Visual Disorder	(3) Sex	(4) Age	(5) Scotomas	(6) Best Distance Acuity with or without Rx		(7)-(16) Reading						(17)-(19) Writing		
					R	L	WD	LM	EM	Rate	UF	WD	LM	EM	UF
11	Scarred Retina	F	38	Yes	20/1200	20/900	4	10x	40x	20	M	4½	6x	21x	u
12	Macular degeneration, retinal hemorrhages	M	77	Yes	20/400	20/400	6½	8½x	21x	35	S	4½	4x	14x	s
13	Optic nerve atrophy (partial)	F	13	Yes	20/400	20/400?	4½	4½x	16x	90	S	3	2x	11x	s
14	Sclerosis of ophthalmic arteries	M	58	Yes	20/800		9½	10x	17x	60	S	9½	4x	6.5x	s
15	Myopic degeneration	M	~60	No	20/200	20/200	6½	5½x	14x	70	S	5	2½x	8x	s
16	Optic nerve injury (possible)	F	38	Yes			4½	13x	46x	(b)	M	4½?	7x?	25x?	m
17	Diabetic retinopathy, cataracts	M	52	Yes	20/650		5½	2½x	7½x	?	U				
18	Glaucoma, cataracts, macular degeneration?	F	85	Yes	FC	LP	5½	3x	8½x	1	U				
19	Retinitis Pigmentosa	M	32	Yes		20/600	3½	8x	37x	2	U	4½	8x	28½x	u
20	Retinal hemorrhages	M	72	Yes	20/800		10½	16x	24x	30	M	6½	2½x	6x	m
21	Stroke, glaucoma	M	50	?	20/1000	20/1000?	¾	12x	34½x	?	U	3½	6x	27½x	u
22	Macular degeneration	M	46	Yes	20/500	20/500?	5	10x	32x	90	S	4½	5x?	18x?	s
23	Retinitis pigmentosa, cataracts	M	57	Yes	20/200	LP	14½	7x	7½x	1	U				
24	Optic nerve atrophy	M	43	Yes	20/500	20/500	6½	6x	15x	40	S	7	1½x	3½x	s

^bThe subjects represented in this line of the table rated an M for reading, but the exact rate at which they read could not be determined. It ranged between 3 and 30 wpm. This was due to one of several causes: the subjects were either too nervous to perform consistently, or they tired easily, or they showed marked signs of senility.

Table 1 -- continued

(1) Code No.	(2) Visual Disorder	(3) Sex	(4) Age	(5) Scotomas	(6) Best Distance Acuity with or without Rx		(8) WD	(9) LM	(10) EM	(11) Rate	(12) UF	(13) Writing			(15) EM	(16) UF
					R	L						WD	LM	EM		
25	Brain tumor (optic nerve)	M	21	Yes	20/200	LP	4	5x	20x	70	S	4	3x?	12x?	s	s
26	Uveitis	M	50	No	20/200		16½	3½x	3½x	50	S	6½	1½x	3½x	s	s
27	Retinal sclerosis, cataracts	M	90	Yes	20/400	20/400	7½	18x	38x	(b)	M	4½	2½x	9x	m	m
28	War injury to eye	M	21	Yes	20/200		1½	12x	128x	35	S	5½	1½x	4½x	s	s
29	Diabetic retinopathy, retinal circulation, Bell's palsy	M	73	Yes			4½	10x	35½x	60	S					
30	Retinopathy	M	57	Yes	20/480	20/240	7½	10x	21½x	48	S	8½	2x	4x	s	s
31	Macular degeneration	M	84	Yes	20/500?	20/500	8½	9x	17x	20	M	8½	2x	4x	m	m
32	Macular degeneration	M	52	Yes	20/480	20/240	6½	8x	19½x	30	M	5½	2x	6x	m	m
33	Glaucoma, cataracts	M	82	Yes		20/1150	2½	8x	51x	30	M	3½	2½x	11½x	m	m
34	Optic nerve atrophy	F	7	?	20/320	20/320	12½	5x	6½x	?						
35	Congenital optic nerve atrophy	M	7	No	20/100	20/160	6½	2x	5x	?						
36	Macular degeneration	M	60	Yes	20/400	20/1200	5½	6x	17½x	25	M	3½	3x?	13½x?	m	m
37	Cataracts, retinopathy	M	~70	Yes	20/480	20/240	12½	4½x	6x	43	S	7½	3x	6½x	s	s
38	Glaucoma	M	57	No	20/550	LP	6½	12½x	31x	15	M	4½	6½x	23x	m	m
39	Cataracts	M	79	?		20/270	5½	4x	11½x	(b)	M	2½	2x	13x	m	m
40	Cataracts, detached retina	M	76	Yes	20/1400	20/300	7½	11½x?	24½x?	(b)	M	3½	2x	9x	m	m

^b See note b on second page of table.

Table 1 -- continued

(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Code No.	Visual Disorder	Sex	Age	Scotomas	Best Distance Acuity with or without Rx		L	WD	Reading			Writing				
					R				LM	EM	Rate	UF	WD	LM	EM	UF
41	Glaucoma, cataracts	F	70	Yes	Nil	20/200		14½	4½x	5x	50	S	6½	2x	5x	8
42	Macular degeneration, arterial sclerosis (eye)	M	69	No	20/240	20/350		6½	6x	15x	50	S	4½	2x	7x	8
43	Glaucoma	F	58	No	Nil	20/650		5½	4x	11½x	50	S	6½	3x	7½x	8
44	Macular degeneration	F	75	?	LP	20/480		6½	12x	29½x	30	M				
45	Macular degeneration	F	54	?	20/350	20/350		11½	5x	7x	64	S	6½	3x	7½x	8
46	Retinitis pigmentosa	M	25	?	20/450	20/450		7½	9x	19x	?	U				
47	Macular degeneration	F	46	No	20/400	20/400		9½	4x	6½x	33	S	6½	1½x	3½x	8
48	Retinitis pigmentosa	M	45	No	20/400	20/200		5½	4½x	13x	35	S	5½	2x	6x	8
49	Macular degeneration	M	69	No	20/320	20/200		11½	4x	5½x	90	S	12½	2x	2½x	8
50	Macular degeneration	F	69	?	20/400	20/1200		5½	9x	26x	3	S	5½	3½x	10x	8
51	Retinitis pigmentosa, cataracts	F	44	Yes	20/120	20/160		8½	1½x	3x	120	S	11½	1½x	2x	8
52	Retrolental fibroplasia	F	9	Yes	20/50	20/480		6½	4x	10x	190	S	?	?	?	8
53	Macular degeneration	M	76	No	20/400	20/400		6½	2½x	6x	(b)	M				
54	Congenital retinoschisis	M	23	No	20/400	20/240		4½	4x	14x	114	S	?	?	?	8
55	Macular degeneration	M	75	Yes	20/50	20/60		12½	7x	9x	60	S	6½	1½x	3½x	8
56	Glaucoma, diabetic retinopathy, cataract	M	~70	Yes	LP	20/200		5½	4½x	13x	45	S	4½	2x	7x	8

^b See note b on second page of table.

Table 1 -- continued

(1) Code No.	(2) Visual Disorder	(3) Sex	(4) Age	(5) Scotomas	(6) Best Distance Acuity with or without Rx		(7)-(10) Reading				(11)-(14) Writing				(15) (16)
					R	L	WD	LM	EM	Rate	UF	WD	LM	EM	UF
57	Optic nerve atrophy, cataracts	M	88	Yes	Nil	20/560	5½	5½x	16x	35	S	?	?	?	s
58	Retinitis pigmentosa	M	26	?	20/150	20/240	13½	2½x	3x	17	M	15½	2x	2x	m
59	Macular degeneration, herpes zoster (eye)	M	80	?	20/400	20/400	7½	12x	25½x	20	M				
60	Diabetic retinopathy	M	~45	Yes	Nil	20/240	6½	7x	17x	60	S	4½	3x?	10½x?	s
61	Glaucoma, stroke, circulatory (retinal)	M	55	Yes	20/1200	20/1200?	3½	12x	55x	(b)	M	3½	6x	27½x	m
62	Optic nerve atrophy	M	46	Yes	20/750		5½	10x	29x	86	S				
63	Cataracts, iritis	F	70	Yes		FC	8½	22x	41½x	?	U				
64	Diabetic retinopathy, glaucoma, cataracts	F	58	Yes?	20/320	Nil	?	?	?	20	M				
65	Macular degeneration, retinal detachment	F	50	Yes	20/450	20/450	8½	4x	7½x	33	S				
66	Cataracts (congenital), Down's syndrome	M	11	No	20/150	20/150	6½	1½x	3½x	31	S				
67	Macular degeneration	M	61	No	20/150	20/400	8½	8x	15x	70	S	8½	2½x	4½x	s
68	Macular degeneration	M	76	Yes	20/800	Nil	4½	10x	35½x	?	U				
69	Cataracts (congenital)	M	18?	Yes	LP	20/1300	2½	3½x	22½x	37	S	2½	2x	13x	s
70	Diabetic retinopathy	M	34	Yes	LP	20/1200	6½	12x?	30x?	(b)	M	6½	4x	10x	m
71	Retinitis pigmentosa	M	29	Yes?	20/900	20/200	15½	4½x	4½x	70	S	8½	1½x	3x	s

^b See note b on second page of table.

Table 1 -- continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Code No.	Visual Disorder	Sex	Age	Scotomas	Best Distance Acuity with or without Rx		Reading				Writing				
					R	L	WD	LM	EM	Rate	UF	WD	LM	EM	
72	Macular degeneration	M	~65	Yes	20/150	20/150	12½	3½x	4½x	75	S	8½	1½x	3x	s
73	Retinitis pigmentosa	M	35	Yes	20/150	20/300	18½	5x	4½x	(b)	M	18½	1½x	1½x	m
74	Glaucoma, retinal detachment	M	~55	No	LP	20/500	2½	2x	13x	55	S	10½	3x	4½x	s
75	Diabetic retinopathy, cataracts	M	52	Yes	20/800	LP	12½	10x	13x	?	U				
76	Optic nerve atrophy (injury)	F	38	Yes	20/400?	20/400	4½	13x	46x	(b)	M	4½?	5x?	18x?	m
77	Macular degeneration	M	~72	Yes	Nil	20/1500	6½	5x	12½x	?	U				
78	Macular degeneration	M	78	No	20/320	20/320	8½	10x	19x	?	U				
79	Macular degeneration	M	~44	Yes	20/200	20/200	6½	4x	10x	31	S	?	?	?	s
80	Cataracts, retinal hemorrhages	F	75	Yes	20/1500	20/1200	?	?	?	?	U				
81	Uveitis, retinal detachment	F	65	Yes		20/400	6½	6½x	16x	31	S	?	?	?	s

^b See note b on second page of table.

inches between the subject's eyes and the monitor screen. This is referred to as the working distance (WD). Column 9 shows the linear magnification (LM) of the image on the monitor screen of the printed material being read. Column 10 gives the effective magnification (EM), which is computed from the relationship

$$EM = (16)(LM)/(WD), \quad (1)$$

using the working distance (WD) and linear magnification (LM) given in columns 8 and 9, respectively. Column 11 shows the best recorded reading rate in words per minute (wpm). Column 12 gives the subject's utility factor (UF) for reading. The UF takes on three values: "S" when the subject could read 31 or more words per minute, "M" when he could read more than 2 words per minute but no more than 30 words per minute, and "U" when he could read no more than 2 words per minute.

Columns 13 through 16 present data regarding the results of the subject's writing with RANDSIGHT I. Columns 13, 14, and 15 contain data similar to that given in columns 8, 9, and 10, respectively, only here they refer to writing rather than reading. The values of WD and LM in Eq. (1) are obtained from columns 13 and 14, respectively (rather than from columns 8 and 9). Column 16 gives the utility factor (UF) for writing and, as in the case of the UF for reading, it also takes on three values: "s" if the subject's handwriting using RANDSIGHT I was legible to the subject as well as to others and was reasonably well spaced, "m" if his handwriting was legible at least by others and was not well spaced, and "u" if he could not write at all or wrote so little or so poorly that a reasonable observer would have to conclude that either he could not write with the aid of the instrument or that he lacked the interest or incentive needed to write successfully with the device.

The reader will note that for subjects 52, 54, and 57 the WD and LM are not known; yet for these people the UF takes on the value "s." This is due to the fact that we obtained a large enough sample of their writing to judge its quality, but due to their insistence on frequently and unpredictably varying the linear magnification and their location relative to the monitor, we were unable to obtain satisfactory values of LM and WD.

Table 2 indicates how many subjects in all and how many subjects in each decade of life are male or female, have visual acuities that fall in specified ranges, scored S, M, or U when reading with RANDSIGHT I, and rated s, m, or u when writing.

Table 3 gives the number of subjects having one and only one of each of the six most frequently reported visual disorders, and the number that have one or more other visual disorders as well. For each of these groups, the table also gives the number who rated S, M, or U for reading and s, m, or u for writing.

Table 4 gives for reading and writing the number of subjects who carried out these operations within specified linear magnification ranges.

For specified effective magnification ranges, Table 5 gives data similar to that given in Table 4.

Table 6 indicates the number of subjects whose reading rate fell within specified limits.

Table 7 gives for reading and writing the number of subjects who carried out these operations at working distances that fell within specified ranges.

We wish to point out that most of the entries in columns 8, 10, 13, and 15 of Table 1 as well as most of those in Tables 5 and 7 differ somewhat from those which appeared in columns 8, 10, 13, and 15 of Table 2 and in Tables 6 and 8 of reference 6. This is due to the fact that after that report was printed we discovered that in computing WD we had not accounted for the half-inch which separates the monitor faceplate from the face of the cathode ray tube. When this correction is made, values of EM are reduced significantly for persons who read or write with their eyes in close proximity to the faceplate of the monitor.

Table 2
AGE DISTRIBUTION OF PARTIALLY SIGHTED SUBJECTS IN TERMS OF SELECTED CHARACTERISTICS

Characteristic	Total Subjects	Age of Subject (years)									
		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
<i>Sex</i>											
Male	59	1	3	6	3	7	11	8	14	5	1
Female	22	2	1	-	4	2	4	3	4	2	-
Total	81	3	4	6	7	9	15	11	18	7	1
<i>Best Visual Acuity (right eye and/or left eye)</i>											
20/50 to 20/100 ^a	5	2	1	-	-	-	-	1	1	-	-
20/100 to 20/200	20	-	1	4	2	4	2	5	2	-	-
20/200 to 20/300	9	-	-	1	-	1	2	1	4	-	-
20/300 to 20/400	16	1	1	-	1	1	2	3	3	3	1
20/400 to 20/500	8	-	-	1	-	2	2	1	1	1	-
20/500 to 20/600	4	-	-	-	1	-	1	-	1	1	-
20/600 to 20/700	2	-	-	-	-	-	2	-	-	-	-
20/700 to 20/800	5	-	-	-	-	1	2	-	2	-	-
20/800 to 20/900	1	-	-	-	1	-	-	-	-	-	-
20/900 to 20/1000	1	-	-	-	-	-	1	-	-	-	-
20/1000 to 20/2000	6	-	1	-	1	-	1	-	2	1	-
Unknown/LP/FC	4	-	-	-	1	-	-	-	2	1	-
Total	81	3	4	6	7	9	15	11	18	7	1
<i>Reading Performance</i>											
S	45	1	4	4	1	9	7	10	7	2	-
M	22	-	-	1	5	-	4	1	6	4	1
U	12	-	-	1	1	-	4	-	5	1	-
?	2	2	-	-	-	-	-	-	-	-	-
Total	81	3	4	6	7	9	15	11	18	7	1
<i>Writing Performance</i>											
s	39	1	3	4	-	8	6	9	6	2	-
m	17	-	-	1	5	-	3	1	4	2	1
u	4	-	-	-	2	-	1	-	-	1	-
?	21	2	1	1	-	1	5	1	8	2	-
Total	81	3	4	6	7	9	15	11	18	7	1

^aThe actual value of the visual acuity is between the two values shown, e.g., less than 20/50 but greater than or equal to 20/100.

Table 3

READING AND WRITING PERFORMANCE OF SUBJECTS WITH THE SIX MOST PREVALENT VISUAL DISORDERS

Visual Disorders	No. of Sub-jects	Reading Performance				Writing Performance			
		S	M	U	?	s	m	u	?
Macular degeneration									
Alone	19	10	6	3	-	10	4	-	5
Plus other visual disorders	<u>10</u>	<u>8</u>	<u>1</u>	<u>1</u>	<u>-</u>	<u>6</u>	<u>-</u>	<u>-</u>	<u>4</u>
Total	29	18	7	4	-	16	4	-	9
Cataracts									
Alone	3	2	1	-	-	1	1	-	1
Plus other visual disorders	<u>15</u>	<u>5</u>	<u>4</u>	<u>6</u>	<u>-</u>	<u>5</u>	<u>3</u>	<u>-</u>	<u>7</u>
Total	18	7	5	6	-	6	4	-	8
Glaucoma									
Alone	2	1	1	-	-	1	1	-	-
Plus other visual disorders	<u>8</u>	<u>4</u>	<u>3</u>	<u>1</u>	<u>-</u>	<u>4</u>	<u>2</u>	<u>-</u>	<u>2</u>
Total	10	5	4	1	-	5	3	-	2
Optic nerve involvement									
Alone	9	4	3	-	2	3	2	1	3
Plus other visual disorders	<u>1</u>	<u>1</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>1</u>	<u>-</u>	<u>-</u>	<u>-</u>
Total	10	5	3	-	2	4	2	1	3
Retinitis pigmentosa									
Alone	6	2	2	2	-	2	2	1	1
Plus other visual disorders	<u>2</u>	<u>1</u>	<u>-</u>	<u>1</u>	<u>-</u>	<u>1</u>	<u>-</u>	<u>-</u>	<u>1</u>
Total	8	3	2	3	-	3	2	1	2
Diabetic retinopathy									
Alone	2	1	1	-	-	1	1	-	-
Plus other visual disorders	<u>5</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>-</u>	<u>1</u>	<u>-</u>	<u>-</u>	<u>4</u>
Total	7	3	2	2	-	2	1	-	4

Table 4
LINEAR MAGNIFICATIONS REQUIRED FOR
SUBJECTS TO READ AND WRITE

Linear Magnification	No. of Subjects	
	Reading	Writing
1x to 2½x	7	32
3x to 4½x	23	14
5x to 6½x	13	7
7x to 8½x	8	2
9x to 10½x	14	--
11x to 12½x	9	--
13x to 14½x	2	--
15x to 16½x	1	--
17x to 18½x	1	--
19x to 20½x	--	--
21x to 22½x	1	--
Unknown	<u>2</u>	<u>26</u>
Total	81	81

Table 5

EFFECTIVE MAGNIFICATIONS REQUIRED FOR
SUBJECTS TO READ AND WRITE

Effective Magnification	No. of Subjects	
	Reading	Writing
1x to 2 $\frac{1}{2}$ x	--	5
3x to 4 $\frac{1}{2}$ x	7	14
5x to 6 $\frac{1}{2}$ x	8	7
7x to 8 $\frac{1}{2}$ x	7	5
9x to 10 $\frac{1}{2}$ x	4	8
11x to 12 $\frac{1}{2}$ x	3	3
13x to 14 $\frac{1}{2}$ x	8	5
15x to 16 $\frac{1}{2}$ x	5	0
17x to 18 $\frac{1}{2}$ x	5	2
19x to 20 $\frac{1}{2}$ x	6	0
21x to 22 $\frac{1}{2}$ x	3	1
23x to 24 $\frac{1}{2}$ x	2	1
25x to 26 $\frac{1}{2}$ x	4	1
27x to 28 $\frac{1}{2}$ x	0	3
29x to 30 $\frac{1}{2}$ x	3	--
31x to 32 $\frac{1}{2}$ x	2	0
33x to 38 $\frac{1}{2}$ x	5	--
39x to 44 $\frac{1}{2}$ x	2	--
45x to 50 $\frac{1}{2}$ x	2	--
51x to 60 $\frac{1}{2}$ x	2	--
61x to 70 $\frac{1}{2}$ x	0	--
128x	1	--
Unknown	<u>2</u>	<u>26</u>
Total	81	81

Table 6

READING RATES ACHIEVED BY SUBJECTS

Reading Rate (wpm)	No. of Subjects
0 to 2	14
3 to 10	1
11 to 20	6
21 to 30	6
(a)	9
31 to 39	13
40 to 49	4
50 to 59	8
60 to 69	6
70 to 79	5
80 to 89	1
90 to 99	3
100 to 109	1
110 to 119	2
120 to 190	<u>2</u>
Total	81

^aThe subjects represented in this line of the table rated an M for reading, but the exact rate at which they read could not be determined. It ranged between 3 and 30 wpm. This was due to one of several causes: the subjects were either too nervous to perform consistently, or they tired easily, or they showed marked signs of senility.

Table 7
SUBJECTS' WORKING DISTANCES FROM
MONITOR SCREEN

Working Distance (in.)	No. of Subjects	
	Reading	Writing
1 to 2½	4	2
3 to 4½	11	19
5 to 6½	32	17
7 to 8½	14	10
9 to 10½	4	3
11 to 12½	8	2
13 to 14½	3	--
15 to 16½	2	1
17 to 18	1	1
Unknown	2	26
Total	81	81

V. SOME OBSERVATIONS ON TEST RESULTS

The four most prevalent visual disorders among our 81 subjects were macular degeneration (29), cataracts (18), glaucoma (10) and optic nerve involvement (10) (see Table 3).

Eighteen out of the 29 subjects who had macular degeneration rated an S for reading and at least 16 scored an s for writing, whereas only 7 out of the 18 subjects who had cataracts rated an S for reading and at least 6 scored an s for writing. Further, at least 38 percent of each visual group rated an S for reading. (See Table 3.) It is also interesting to note that the 4 subjects who had macular degeneration and a retinopathy (primarily retinal hemorrhages) all rated S for reading and s for writing. Of the 4 subjects who had a retinopathy and glaucoma 1 rated s, 2 M and 1 U relative to reading and 1 rated S, 1 m and 1 u for writing. Of those who had cataracts and a retinopathy 1 rated S, 1 M and 3 U with respect to reading and 1 s and 1 m with respect to writing.

Fifty-nine of the subjects were male and 22 female and their ages ranged from 7 to 90. Thirty-seven of them were 60 years old or older, 37 were between 20 and 59 years old, and only 7 were between 7 and 19 years old. (See Table 2.)

Fifty-three of the 81 subjects definitely had scotomas. These scotomas became known to us either through the subject's medical record, our observations of his behavior during the test procedure, our direct questioning, or through the subject's comments and remarks. A cursory examination was carried out to determine the general location and magnitude of scotomas, but our already overtaxed procedure did not permit us to carry out detailed tangent screen tests.

Only 2 of the 81 subjects (numbers 20 and 28) had suffered a visual loss within the year prior to visiting us. Although they rated UFs of M and m and S and s, respectively, they were nevertheless difficult to work with. This was no doubt due to their deep emotional

involvement with themselves resulting from the negative change in their visual status.

The distance visual acuity (equivalent Snellen acuity at 20 ft) for the 81 subjects ranged between 20/50 and LP. Forty-five of the 81 subjects have acuities that are less than 20/100 but no worse than 20/400. (See Table 2.)

The linear magnifications selected for reading by the 81 subjects ranged between $1\frac{1}{2}x$ and $22x$. Seventy-four of them preferred a linear magnification in the range $1\frac{1}{2}x$ to $12\frac{1}{2}x$, and 23 in the range $3x$ to $4\frac{1}{2}x$. In all but one case, smaller linear magnifications were preferred for writing than for reading, and 46 of the subjects wrote at linear magnifications ranging between $1x$ and $4\frac{1}{2}x$. The effective magnifications relative to reading for 72 of the 81 subjects ranged rather evenly between $3x$ and $32\frac{1}{2}x$.^{*} Relative to writing, 26 of the 55 subjects wrote at effective magnifications ranging between $3x$ and $8\frac{1}{2}x$. (See Tables 4 and 5.)

Forty-five of the 81 subjects rated an S for reading and 39 rated an s for writing; 67 rated either an S or M for reading and 56 rated an s or m for writing. This is very encouraging, because the subjects reached this level of achievement with no more than 30 minutes of actual experience with RANDSIGHT I. Genensky's experience with CCTV systems indicates that most partially sighted people who initially read 30 or more words per minute can easily expect that over time

^{*}The only published study of test results using a closed-circuit TV system which we could find was that of C. A. Weed.⁸ He used a CCTV system that incorporated a 19-in. Shibaden TU-19UL monitor and a Shibaden HV-50 or HV-14 camera. Magnification changes were made by adding or subtracting extension tubes between the fixed focal length lens and the camera. Illumination was supplied by a 60w gooseneck desk light or by a Tensor desk lamp. Reading materials were moved completely by hand on the table surface below the down-pointing camera. In the tests, which were carried out with 14 subjects, this CCTV system was compared with two optical magnifiers. This comparison is of dubious value, because the subjects were required to view an image at a *fixed* magnification of $10x$ at a *fixed* distance (40 cm) from the monitor. Thus Weed was assuming that all of his subjects could use a CCTV system at one and the same *effective* magnification, namely, $10x$. Even a cursory look at Table 5 will show that this is an unjustified assumption.

they will at least double their reading rate.* This observation appears to be supported by the experience of some of our subjects; for example, after reading between 5 and about 20 minutes, subject number 49, using newspaper column type, increased his reading rate from 50 to 90 wpm, and subjects 60 and 69, using double-spaced typewritten material, increased their reading rates from 25 to 40 to 60 wpm and from 37 to 45 to 65 wpm, respectively. It is also interesting to note that of the 22 subjects who rated an M for reading, at least 10 read between 20 and 30 words per minute. It is likely that persons who can read as few as 20 words per minute can also expect to double their reading rate with time.

It is important to recall that all our reading rate measurements were made with the subject reading aloud. Therefore, it is not unreasonable to assume that the reading rates of some subjects, particularly those who read, say, 50 or more words per minute, would have been higher had they read to themselves. However, for very slow readers, especially those who had difficulty putting individual letters, syllables, or words together, we conjecture that their reading rates would not have changed appreciably had they read to themselves.

Another factor that may have limited some of our subjects in their reading or writing performance is that we use only 9-in. monitors. Conversations with persons involved in the manufacture and sale of CCTV systems indicate that the vast majority of their customers prefer to use much larger monitors. It is therefore possible that some of our subjects were inhibited by our 9-in. monitors and would have performed better if they could have used, say, a 12-, 15-, or 17-in. monitor.

Although Tables 1 through 7 do not record subject preference for contrast reversal, our records show that over 60 percent of the subjects, when viewing ordinary reading and writing materials, definitely preferred viewing a negative image to a positive one.

* This may not be true of persons who initially read at relatively high reading rates, say, in excess of 150 words per minute. There may be an upper limit at which a person can read with the aid of a CCTV system, which is set by the CCTV system itself and not by an inherent limitation of viewer ability. Edwin Mehr, O.D., of the University of California at Berkeley, suggested this possibility to us.

REFERENCES

1. Genensky, S. M., P. Baran, H. L. Moshin, and H. Steingold, *A Closed Circuit TV System for the Visually Handicapped*, The Rand Corporation, RM-5672-RC, August 1968. Also published in *Research Bulletin of the American Foundation for the Blind*, No. 19, June 1969, pp. 191-204.
2. Genensky, S. M., *Some Comments on a Closed Circuit TV System for the Visually Handicapped*, The Rand Corporation, P-3984, December 1968. Also published in *The Optometric Weekly*, Vol. 60, No. 14, April 3, 1969; *American Journal of Optometry and Archives of American Academy of Optometry*, Vol. 46, No. 7, July 1969, pp. 519-524; and Hearing before the Subcommittee on Education of the Committee on Labor and Public Welfare, U.S. Senate, 91st Cong., 1st Sess., on S.1611 to amend Public Law 85-905 to provide for a National Center on Educational Media and materials for the handicapped and for other purposes, April 23, 1969, pp. 45-48.
3. Genensky, S. M., H. L. Moshin, and H. Steingold, *A Closed Circuit TV System for the Visually Handicapped and Prospects for Future Research*, The Rand Corporation, P-4147, July 1969. Also published in *Annals of Ophthalmology*, Vol. 2, No. 3, June 1970, pp. 303-308.
4. Genensky, S. M., *Closed Circuit TV and the Education of the Partially Sighted*, The Rand Corporation, P-4343, March 1970. Also published in *Educational Technology*, Vol. 10, No. 8, August 1970, pp. 27-31.
5. Clewett, R. W., S. M. Genensky, and H. E. Petersen, *An X-Y Platform for RANDSIGHT-Type Instruments*, The Rand Corporation, R-831-HEW/RC, August 1971.
6. Genensky, S. M., H. E. Petersen, H. L. Moshin, R. W. Clewett, and R. I. Yoshimura, *Advances in Closed Circuit TV Systems for the Partially Sighted*, The Rand Corporation, R-1040-HEW/RC, April 1972.
7. Boehm, George A. W., "Sam Genensky's Marvelous Seeing Machine," *The Reader's Digest*, January 1971, pp. 27-34.
8. Weed, C. A., "Comparison of Television Reader for the Partially Sighted with Optical Reading Aids," *Hartford Hospital Bulletin*, Vol. 25, No. 3, September 1970, pp. 186-189.





HV5702 Genensky, Samuel M.; H.L. c.1
G286 Moshin and H.E. Petersen.
P416 PERFORMANCE OF PARTIALLY
SIGHTED WITH RANDSIGHT I
EQUIPPED WITH AN X-Y PLAT-
Date Due FORM. (1973)

HV5702 c.1
G286 Genensky, Samuel M.; H.L.
P416 Moshin and H.E. Petersen.
PERFORMANCE OF PARTIALLY SIGHTED
WITH RANDSIGHT I EQUIPPED WITH AN
X-Y PLATFORM.
(1973)

DATE	ISSUED TO
	<i>Glenn Casey</i>

AMERICAN FOUNDATION FOR THE BLIND
15 WEST 16th STREET
NEW YORK, N.Y. 10011

PERFORMANCE OF PARTIALLY SIGHTED WITH
RANDSIGHT I EQUIPPED WITH AN X-Y PLATFORM